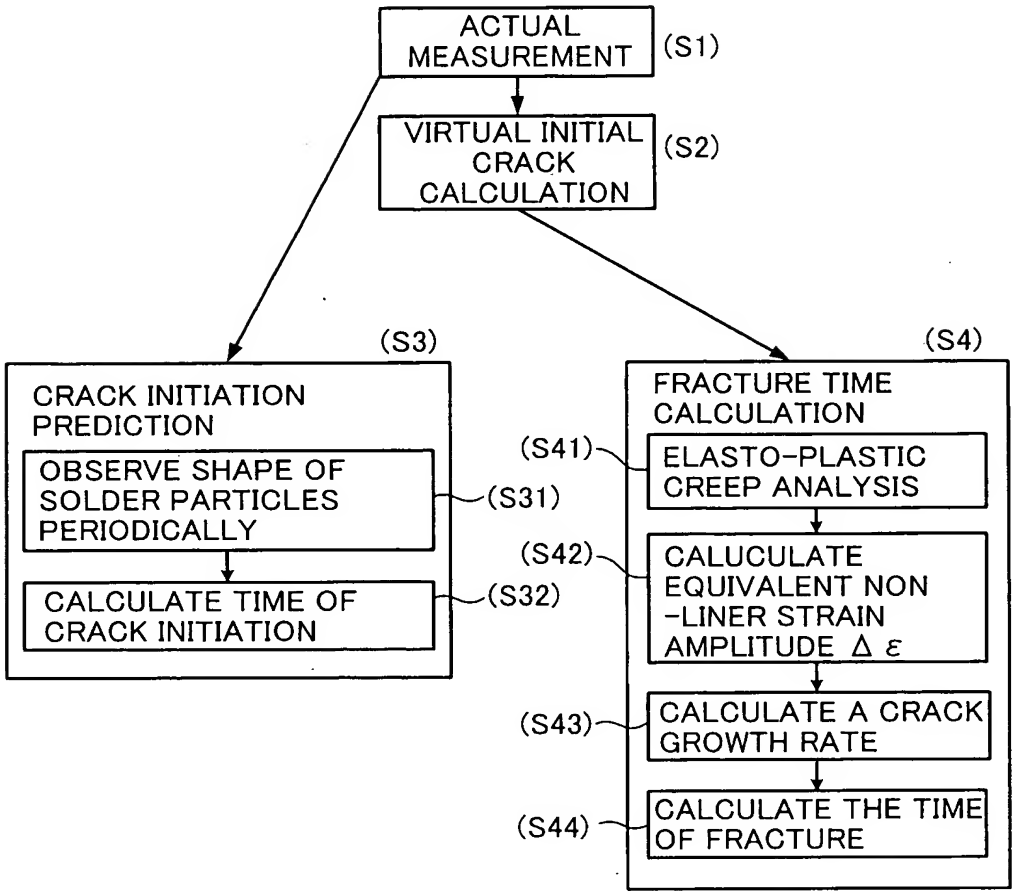

ACTUAL MEASUREMENT
(S1)
VIRTUAL INITIAL CRACK CALCULATION
(S2)
(S3)
CRACK INITIATION PREDICTION
OBSERVE SHAPE OF SOLDER PARTICLES PERIODICALLY
(S31)
CALCULATE TIME OF CRACK INITIATION
(S32)
(S4)
FRACTURE TIME CALCULATION
(S41)
ELASTO-PLASTIC CREEP ANALYSIS
(S42)
CALUCULATE EQUIVALENT NON -LINER STRAIN AMPLITUDE Δ ε
(S43)
CALCULATE A CRACK GROWTH RATE
(S44)
CALCULATE THE TIME OF FRACTURE

Fig. 1

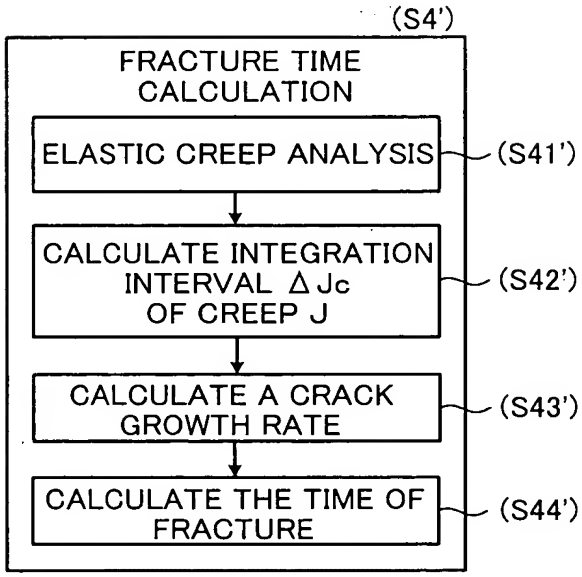

(S4')
FRACTURE TIME CALCULATION
ELASTIC CREEP ANALYSIS
(S41')
CALCULATE INTEGRATION INTERVAL ΔJc OF CREEP J
(S42')
CALCULATE A CRACK GROWTH RATE
(S43')
CALCULATE THE TIME OF FRACTURE
(S44')

Fig. 2

Fig. 3

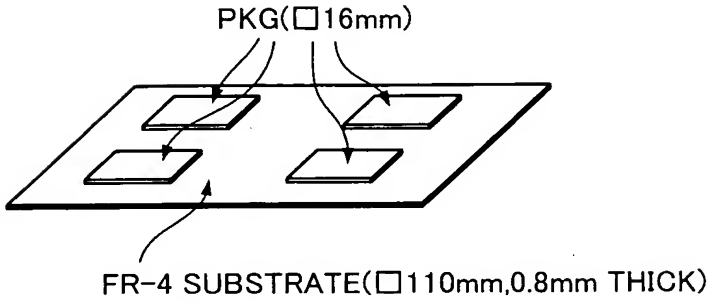


Fig. 4

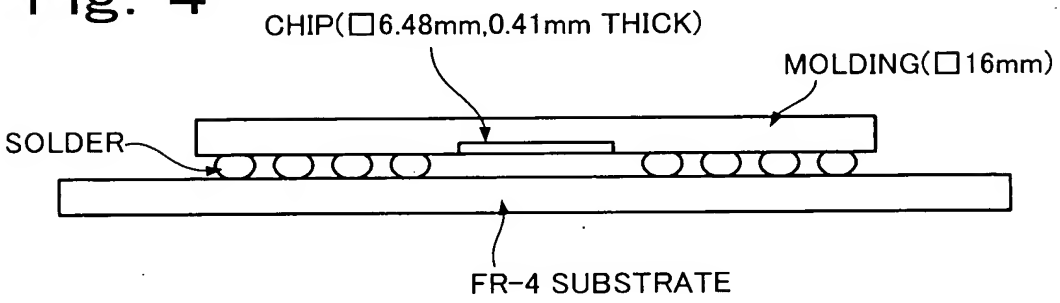
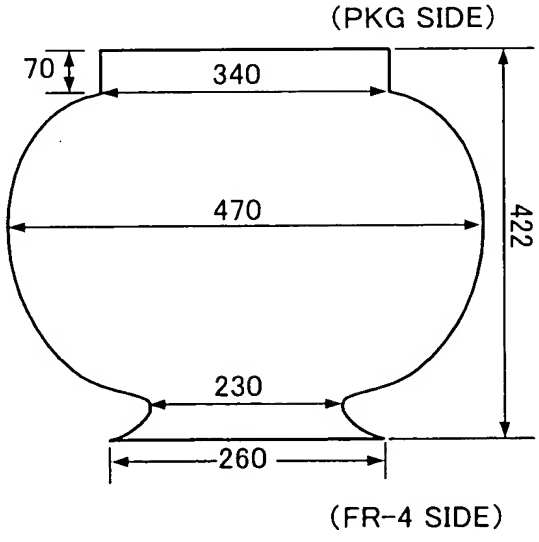


Fig. 5



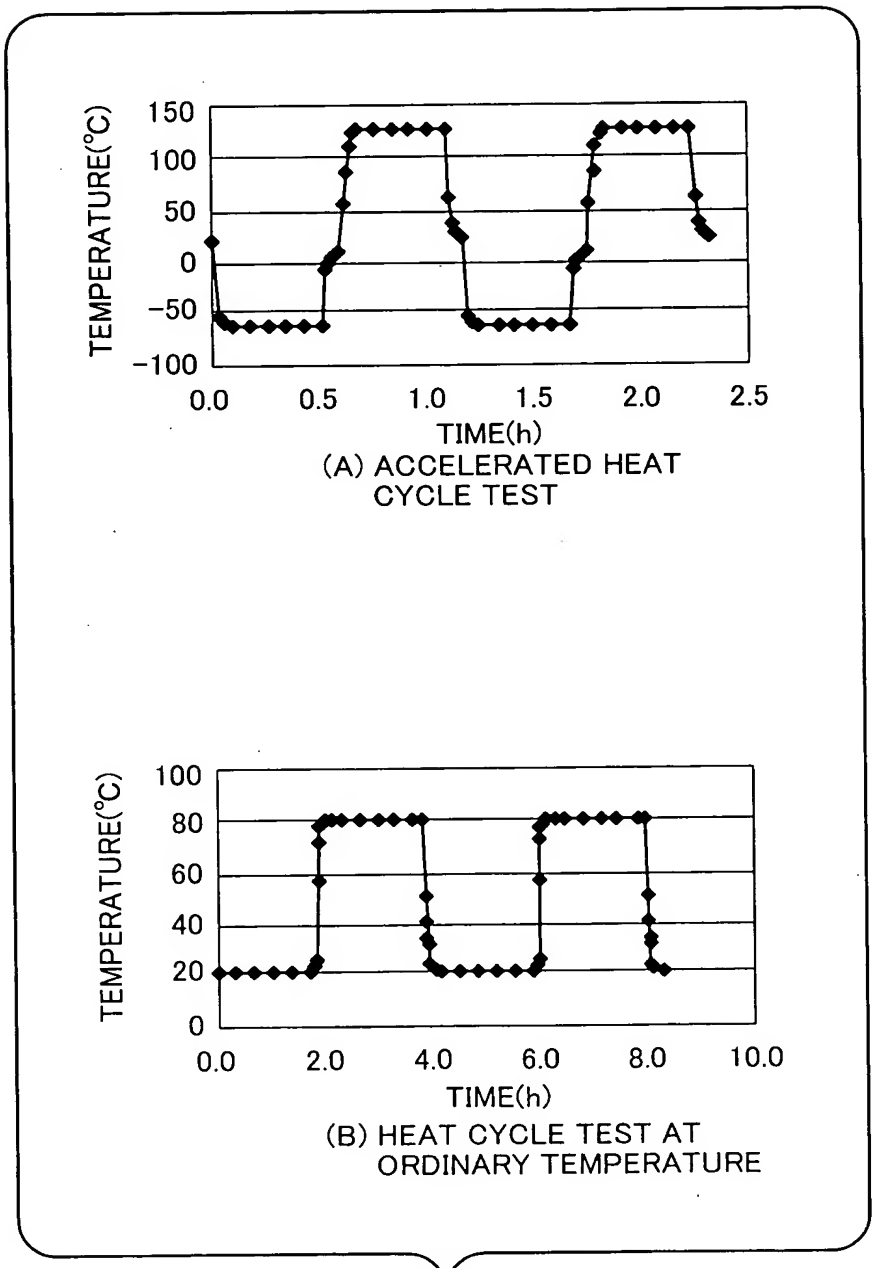

TEMPERATURE(°C)
150
100
50
0
−50
−100
0.0
0.5
1.0
1.5
2.0
2.5
TIME(h)
(A) ACCELERATED HEAT CYCLE TEST
TEMPERATURE(°C)
100
80
60
40
20
0
0.0
2.0
4.0
6.0
8.0
10.0
TIME(h)
(B) HEAT CYCLE TEST AT ORDINARY TEMPERATURE

Fig. 6

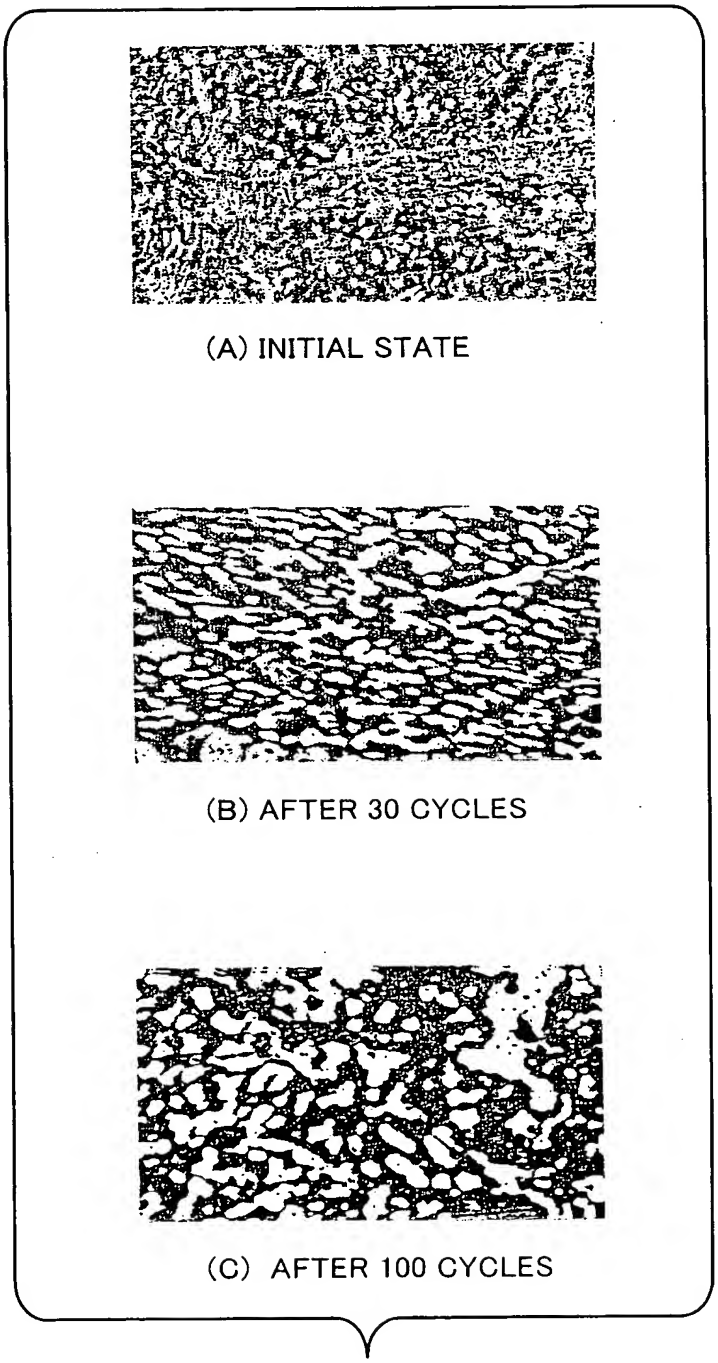


Fig. 7

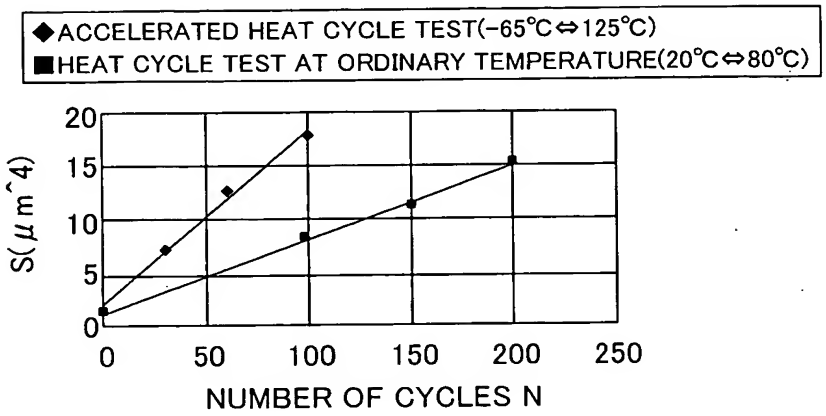

◆ACCELERATED HEAT CYCLE TEST(-65℃⇔125℃)
■HEAT CYCLE TEST AT ORDINARY TEMPERATURE(20℃⇔80℃)
S(μm^4)
20
15
10
5
0
0
50
100
150
200
250
NUMBER OF CYCLES N

Fig. 8

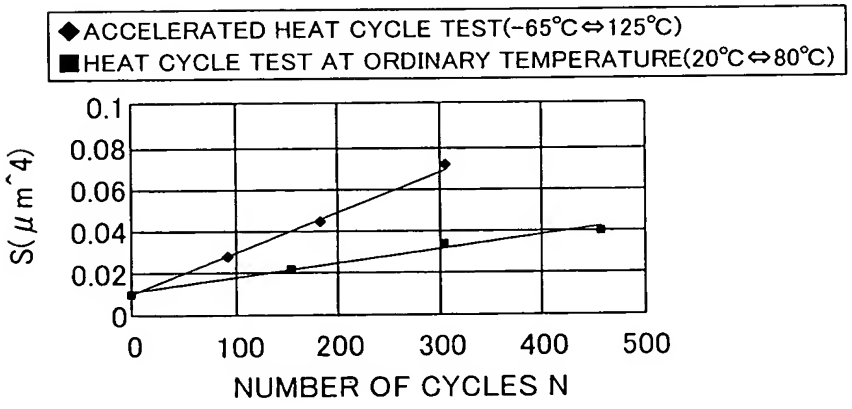

◆ACCELERATED HEAT CYCLE TEST(-65℃⇔125℃)
■HEAT CYCLE TEST AT ORDINARY TEMPERATURE(20℃⇔80℃)
S(μm^4)
0.1
0.08
0.06
0.04
0.02
0
0
100
200
300
400
500
NUMBER OF CYCLES N

Fig. 9

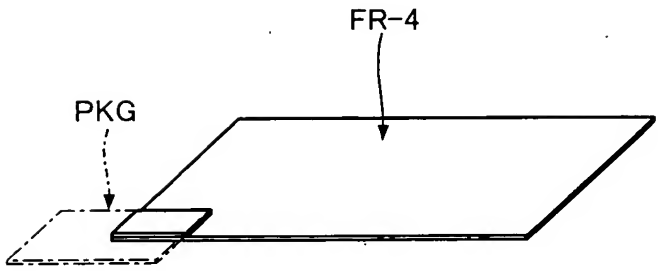

FR-4
PKG

Fig. 10

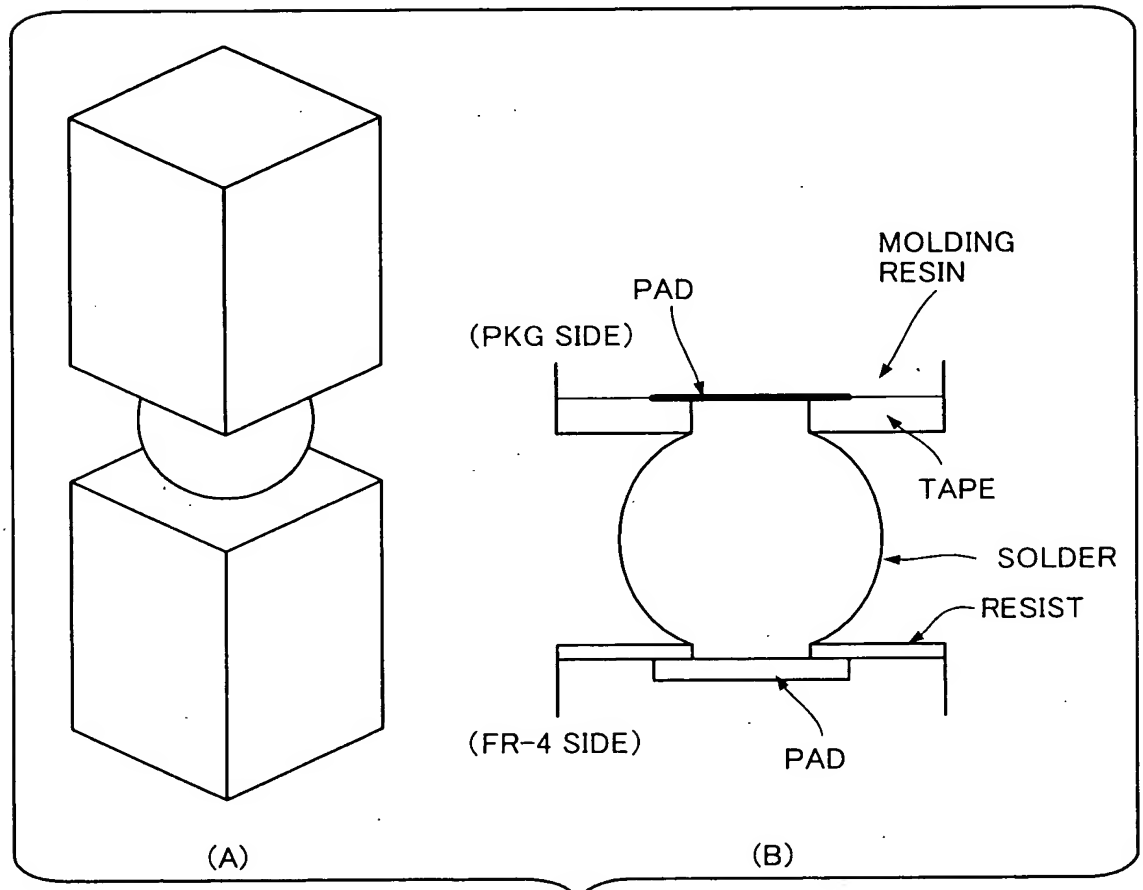

MOLDING RESIN
PAD
(PKG SIDE)
TAPE
SOLDER
RESIST
(FR-4 SIDE)
PAD
(A)
(B)

Fig. 11

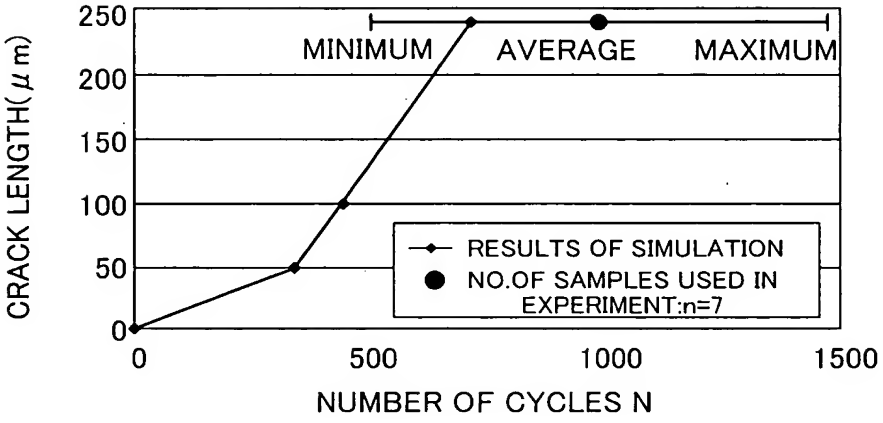

250
200
150
100
50
0
CRACK LENGTH(μm)
MINIMUM
AVERAGE
MAXIMUM
RESULTS OF SIMULATION
NO.OF SAMPLES USED IN EXPERIMENT:n=7
0
500
1000
1500
NUMBER OF CYCLES N

Fig. 12

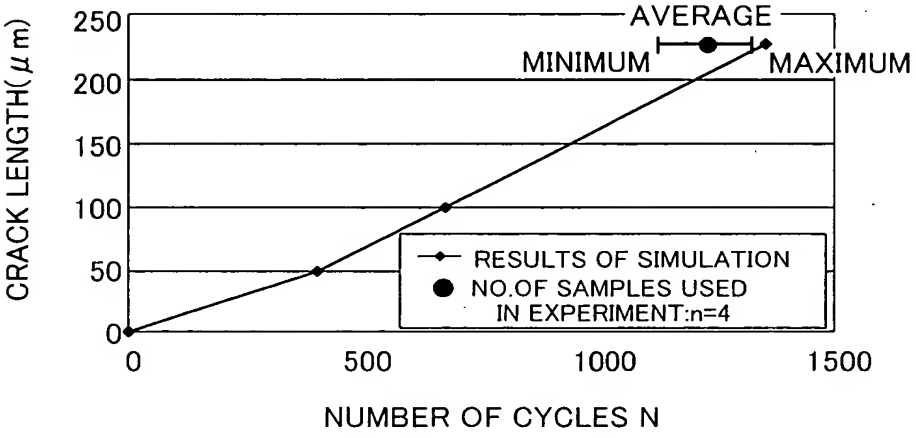

250
200
150
100
50
0
CRACK LENGTH(μm)
AVERAGE
MINIMUM
MAXIMUM
RESULTS OF SIMULATION
NO.OF SAMPLES USED IN EXPERIMENT:n=4
0
500
1000
1500
NUMBER OF CYCLES N

Fig. 13

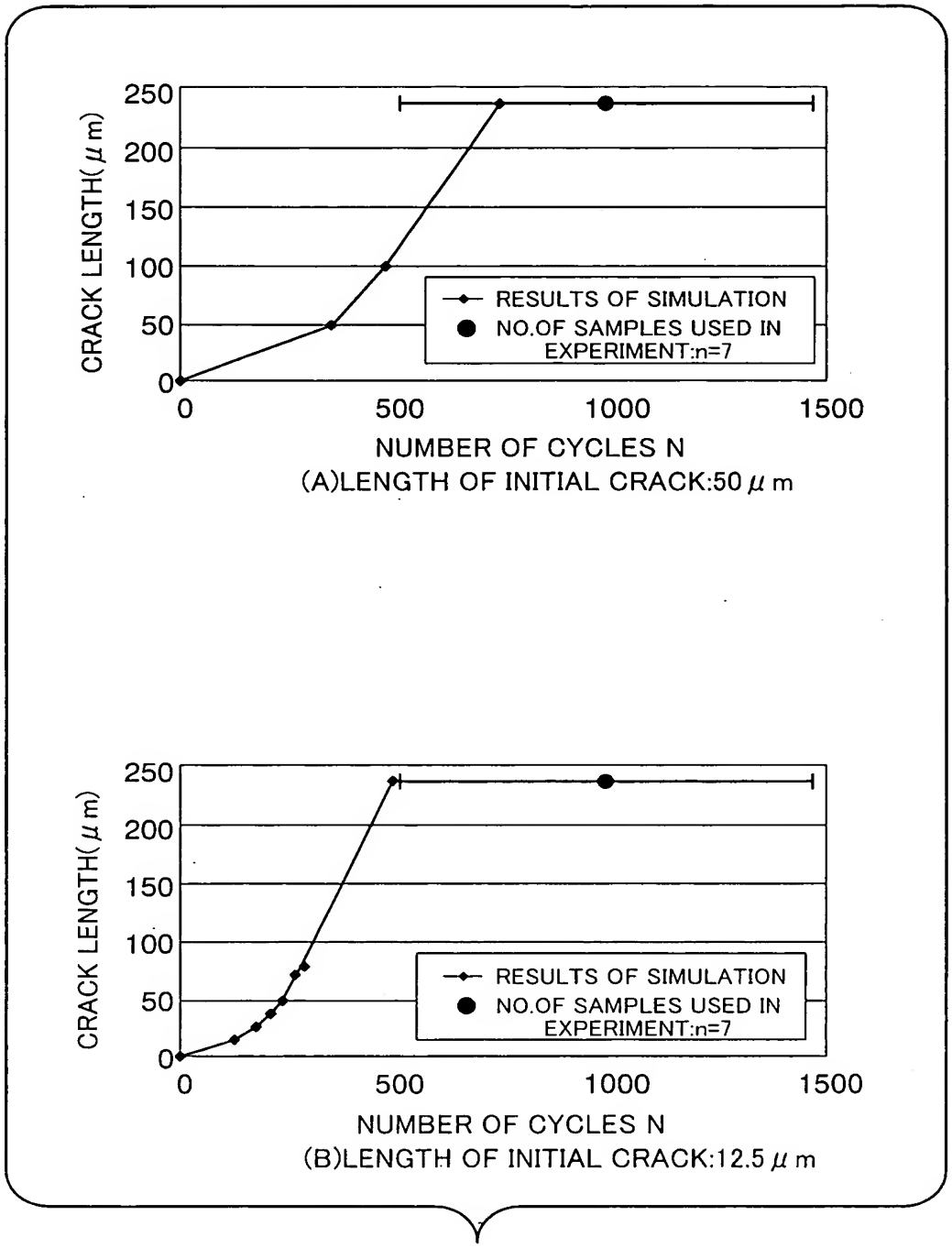

CRACK LENGTH(μm)
250
200
150
100
50
0
0
500
1000
1500
RESULTS OF SIMULATION
NO.OF SAMPLES USED IN EXPERIMENT:n=7
NUMBER OF CYCLES N
(A)LENGTH OF INITIAL CRACK:50 μm
CRACK LENGTH(μm)
250
200
150
100
50
0
0
500
1000
1500
RESULTS OF SIMULATION
NO.OF SAMPLES USED IN EXPERIMENT:n=7
NUMBER OF CYCLES N
(B)LENGTH OF INITIAL CRACK:12.5 μm

Fig. 14